SCIENCE

VOL. 85 FRIDAY, APRIL 23, 1937 No. 2208

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

BOTANIC GARDENS IN SCIENCE AND EDUCATION[1]

By C. STUART GAGER

DIRECTOR, BROOKLYN BOTANIC GARDEN

ONE could hardly expect to find an intellectual climate more salubrious for discussing things botanical and horticultural than that of the environs of Swarthmore. It is located in the only state of our union that has any reference to plant life in its name.

Whether it was something in the name, "Penn's Woods," or something in the blood of the early settlers—or a combination of both—I am unable to say, but the fact remains that botanic gardens and arboretums just naturally came into being in this region like mushrooms after a rain, springing up here and there over a period of some 200 years.

The Rosicrucians apparently came first with their medicinal plant garden on the banks of the Wissahickon in the very first years of the eighteenth century. Then came, in succession, the botanic garden of Christopher Witt in Germantown, in 1708; Bartram's famous garden in 1728; Humphrey Marshall's garden at West Bradford in 1773; John Evans's arboretum, near Bryn Mawr, in 1828; the Painter Arboretum, established by Minshall Painter and his brother about 1835; William Darlington's arboretum, laid out as part of the public park at Westchester, about 1850; the old botanic garden of the University of Pennsylvania, initiated by Professor McFarland in 1892; and then the Arthur Hoyt Scott Foundation here at Swarthmore, beginning in 1928 and antedating by four years the Morris Arboretum in Philadelphia, which is the youngest offspring of botanical interest in this region.

[1] Founder's Day address, delivered at Swarthmore College on October 31, 1936.

One feels almost out of breath by the mere recital of names and dates. I know of no other region of similar size in America that can boast of so many botanic gardens. In a very real sense Swarthmore is at the American center of distribution of botanic gardens, for the idea spread from this region to New York and elsewhere throughout the nation.

But, for some reason or other it did not spread very fast. Almost every city of any considerable size in Europe has its botanic garden and has had for a generation or more. The same is true of the Old World universities—Pisa, Padua, Paris, Oxford, Cambridge, Berlin, Munich, Amsterdam, Copenhagen and others.

In America municipal botanic gardens are rare, and as late as 50 years ago only a few American universities had botanic gardens. Only about fifty American cities out of some 980, having a population of 10,000 or more, can now boast of a botanic garden, and 22 of these were established during the past 25 years—most of these 22 during the past ten years.

It is significant to see these institutions coming into being at the rate of nearly one a year during the period of a world war and a world-wide economic depression. Probably no other kind of scientific or educational institution has multiplied so rapidly during the past quarter century. This is only one of numerous evidences of an expanding and deepening interest in botanical and horticultural science during this period. The establishment of the Arthur Hoyt Scott Foundation places Swarthmore College in the vanguard of educational progress in this important field of knowledge.

The promotion of gardens and of gardening has by no means been limited to gardeners. It has always been a concern of great philosophers and great rulers. Pliny tells us, in his "Natural History," that Epicurus, "that connoisseur in the enjoyments of a life of ease," was the first to lay out a garden in Athens, where he met his students and did his teaching; "up to his time," says Pliny, "it had never been thought of to dwell in the country in the middle of the town." When Epicurus died (in 270 B.C.), he left his garden, known as the "Gardens of Epicurus" (Κῆποι Επικούρου), and some funds to two trustees, who devoted the garden to the school of Epicurus.

Charlemagne established gardens by royal edict, and even prescribed what plants were to be grown in them. It is of profound significance that a man who had such tremendous administrative responsibilities as did Charlemagne should consider that the establishment of gardens merited his personal attention.

Cosmo de Medici (1555) and King Henry IV of France (Montpellier, late sixteenth century) were also among the great rulers who established gardens. One of the great botanic gardens of the world—that at Kew, near London, dates from the appointment of William Aiton to organize a physic (or medicinal plant) garden for the Princess Augusta, Dowager Princess of Wales. These gardens remained a private possession of the crown until as late as 18[illegible] when "Kew" was made a public garden.

Perhaps the outstanding instance of the founding of a botanic garden by a great scholar is the garden established at Athens by Aristotle, who is said to have endowed it from his wealth and made his pupil, Theophrastus, the "director" of it.

History tells us that Theophrastus conducted this garden for some 50 years. When he died, in 285 B.C., he left it to a group of his intimate friends—perhaps a kind of board of trustees. It appears to have functioned as a center of botanical study for about three generations. Of special interest, at this time and place, is the fact that the Athens botanic garden quite probably partook largely of the nature of an arboretum. This is suggested, in part, by the fact that of Theophrastus's book, "Inquiry into Plants,"[2] five books out of nine and 426 pages out of 476 are devoted to trees and shrubs. He describes 183 kinds—an unusually large number for that day.

By the generosity of another wealthy friend, Theophrastus was enabled to improve the Athens botanic garden on an extensive scale. The name of this early patron and benefactor of botany, the spiritual ancestor of Mrs. Arthur Hoyt Scott and Mrs. Owen Moore, was Demetrius Phalereus; it should be remembered and perpetuated, as theirs will be, wherever botanic gardens and arboretums are established and maintained.

Theophrastus, as we all know, was not only a botanist but a philosopher—an early "encyclopedist" of learning. There have been preserved the titles of more than 225 books which he wrote; and besides this productive scholarship, he directed a school of some 2,000 students in which he also taught.

With all these duties how could Theophrastus acquire the vast knowledge of botany which is revealed to us in his two-volume treatise of nine books? For there were in classic Greece, as here and now, only 24 hours in a day, and Theophrastus, like modern professors, had to devote some hours each day to eating and sleeping.

Theophrastus traveled little, yet he gives accurate information about the wild and cultivated plants of Greece and other countries. This was largely made possible by the existence of the Athens botanic garden, where Theophrastus had his home, took walks and studied and thought. It was his first-hand observations in this garden that enabled Theophrastus to lift the study of plants out of the limbo of myths and

[2] English translation by Sir Arthur Hort, London, 1916.

bles, which cluttered up the writings of his predecessors.

Moreover, the books he wrote on plants are the only definite source of information as to what trees were known to the nations of antiquity prior to the Greeks.

We have in this fascinating story, of which the students of the old classical curriculum of American colleges appear to have been generally indifferent, a "random sample" of the contribution of botanic gardens, from that day to this, to the advancement of science and education.

It was the *greatest* intellects of the *greatest* civilization the world has ever known that considered the study of plants important and laid the foundations of botanical science, to the immeasurable advantage of succeeding generations. The Arthur Hoyt Scott foundation has not only made possible here a future development along modern trends, but has placed Swarthmore College, in a new way, in the line of descent from one of the glories of ancient Greece.

This gradual penetration of the botanic garden idea from Greece and Italy up through France, Germany and England to Sweden is an interesting special case of the general principle that while humanity, throughout European history, has migrated from north to south, culture has migrated in the opposite direction.[3] It is encouraging and reassuring, in this connection, to note that learning and culture tend to diffuse themselves among the people; they have had a vitality and momentum that have helped to carry them over a wider geographical range than the reach of physical migration of the human race. If this diffusion of learning and culture should continue, we might, in time, become really civilized. Who can tell!

A recent writer has compared 300 years in the life of a university to 25 years in the life of a man. On that basis here is Swarthmore College in "manhood's prime vigor," with its roots and its branches and its background in a soil and air and tradition of botanical science. What a logical event in its history, therefore, was the establishment of the Arthur Hoyt Scott Foundation, as stated by Mr. Wister in his first Report, "for the encouragement of horticulture in its broadest sense." Should not every educational institution whose primary aim is to promote knowledge and culture recognize in its curriculum, as one of the new humanities, the study of that science whose field is the fundamental art of civilization?

I speak of the natural sciences as "new humanities" because, if they are rightly taught, they not only keep us abreast of the most recent advances of knowledge and the method of knowledge, but they carry us back to the fountain head of modern learning as surely as did the study of Homer and Aristotle and Virgil and Livy.

Much time was given in the old classical curriculum to Aristotle, and yet how rarely was any time devoted to his scientific writings and how few realized that his scientific work had meaning for moderns. It is he, said Osler, who "speaks for the first time the language of modern science, and indeed he seems to have been first and formost a biologist . . . the founder of modern biology."

The tragedy of the shelving of the classical curriculum has not been the elimination of a general knowledge of the Greek language, great as that loss may be; it is the severing of our vital connection with the great thinkers of classic Greece while advancing the sciences *they* found by the method in which *they* were the pioneers. From the standpoint of scholarship and culture, it is almost like trying to turn on the electric light when the wires from the dynamo are cut.

I am not intending to read a belated obituary of the classical curriculum, in which I am a firm believer (for some!), nor to pronounce a panegyric on the ancient Greeks, but to point out how close we have come to overlooking one of the great cultural and liberalizing advantages to be derived from botanical science when studied and taught in historical perspective.

A few moments ago I referred to the fact that Epicurus established his "Gardens" in Athens as an *educational center*. Herein lies a fundamental distinction between a botanic garden or arboretum and a park. A public park is intended to serve hygienic, esthetic and recreational ends. So may a botanic garden. No one ever thinks of a public park as an educational center; but that is precisely what a botanic garden or arboretum essentially is. It is, in effect, an outdoors museum of plant life, about which (as in the case of a modern museum) is organized a program for the advancement and diffusion of knowledge.

To illustrate briefly: In planting a park the main consideration is beauty. No attention whatever need be paid to the botanical affinities of the trees and shrubs and herbaceous plants; the only important consideration is a beautiful landscape effect.

Beauty is equally essential in a botanic garden, just as it is essential in every aspect of life. Nothing is ever right unless it is as beautiful as we can make it. But there is one handicap in laying out a botanic garden, for some regard must always be had to botanical considerations. Our problem is to make the botanic garden or the arboretum as beautiful as we can with necessary regard for these other essentials.

Then, after the planting is done, the plants are to be labeled. This *may* be done in a park; in a botanic garden it *must* be done, for it is the primary purpose

[3] A. Wyatt Tilby, "The Distribution of European Genius. The Nineteenth Century and After," January, 1936, p. 47.

of the plantations to be educational. And then comes the organization of scientific research, growing out of, furthered by and enriching the collection of living plants; and the program of lectures, classes, field study, technical and popular publication and other educational techniques by which a botanic garden fulfills its mission and justifies the ability and effort and financial support which made it possible.

One can hardly overemphasize the importance of a study of trees. They make the beauty of our landscapes; they make possible our parks; they supply the shade and beauty of our streets. It was Loudon who declared that, next to buildings, trees and shrubs are "the most important ornaments which can be introduced into a country." The mere mention of the word "wood" suggests the innumerable ways in which trees are essential in our daily lives. Surely we ought to be interested, not only to use and enjoy them, but to know all we can about them; and whatever man is interested to know, about the world in which he lives, is worth finding out—if we can.

Of course, the ideal of the modern botanic garden and arboretum has been a gradual evolution; and yet the germ of this ideal—the essential conception—was present almost from the first. We have noted this for botanic gardens in general; the fact stands out in bold relief for arboretums.

The word arboretum, as an English word, is not quite 100 years old. It appears to have been first used by John C. Loudon, the English botanist, in his eight-volume work on "The Trees and Shrubs of Britain," published in 1838. In the body of the text he uses it freely, for example, "collecting trees from a distance . . . to assemble them in one plantation or arboretum."

The Latin dictionary, after defining *arboretum* as "a place grown with trees," gives this quotation from the Roman historian, Quadrigarius: "arboretum ignobilis verbum est, arbusta celebratius." This "ignoble" word, however, has come to designate a very noble institution.

The conception of an arboretum as a scientific center is at least as old as 1627, when the first edition of Lord Bacon's "New Atlantis" was published. The "Head of Solomon's House," describing the intellectual condition of the country, states that "The End of our Foundation is the Knowledge of Causes." Enumerating the "Preparations and Instruments" for accomplishing this end, he says:

> We have also large and various Orchards and Gardens, wherein we do not so much respect Beauty, as Variety of Ground and Soyle, proven for diverse Trees and Herbs. . . . In these we practice all Conclusions of Grafting, and Inoculating, as well of Wilde Trees, as Fruit-Trees, which produce many Effects. And we make (by Art) in the same Orchards, and Gardens Trees and Flowers to come earlier, or later than their Seasons; and to come [illegible] and bear more speedily than by their Naturall Cour[se] they doe. We make them also by Art greater much th[an] their Nature; and their Fruit greater, and sweeter, a[nd] of differing Taste, Smell, Colour, and Figure, from th[at] Nature. . . . We have also Meanes to make . . . [one] Tree or Plant turn into another.

A remarkable forecast of the program of pla[nt] propagation, plant breeding and experimental evol[u]tion in our modern institutions, which has not onl[y] advanced our knowledge of plant life, but has don[e] so much to add to the health and pleasure and wealt[h] and enlightenment of the world. The report of th[e] British Parliamentary Commission, appointed abo[ut] 1838 to report on the question of continuing the Roy[al] Botanic Garden at Kew, speaks of it as "one of th[e] first proofs of wealth and civilization."

It was more than one hundred years after Lor[d] Bacon's prophecy that Duhamel du Monceau, [a] Frenchman prominent in the scientific and cultura[l] life of his time, formed large collections of trees an[d] shrubs on his two estates, devoting special attentio[n] to the rarest and finest, as Arthur Scott did here. Duhamel's collections appear to constitute the firs[t] arboretums developed primarily for the purpose o[f] promoting the scientific study of trees. The result[s] of Duhamel's studies based on this arboretum were published in 1755 under the title "Traité des arbres e[t] arbustes qui se cultivient en France," and this is probably the earliest modern scientific work on trees.

Those who realize the civic and economic importance of arboriculture, silviculture and scientific forestry have always recognized the great advantages of an arboretum in promoting those sciences.

When the subject of forestry was just beginning to take shape as a major division of botanical science in the last quarter of the nineteenth century, James Hutton Balfour, who became keeper (director) of the Royal Botanic Garden at Edinburgh in 1845, organized a portion of that garden as an arboretum just before he retired in 1879. The stated purpose of this was to facilitate the work of students of forestry in the University of Edinburgh. This is an early, if not the earliest, instance of a modern botanic garden developing an arboretum as one of its main divisions.

And now, what are the results of the scientific and educational work, made possible or promoted by botanic gardens and arboretums? It would not be possible, in one lecture, to enumerate all of even the most important results. They are published in books, reports and magazine articles that would make a large library. But two or three cases may be mentioned.

(1) For reasons of sentiment let us take a case near home. I have already spoken of Bartram's Garden. In the fall of 1765 John Bartram and his son, William, made a botanical reconnaissance through the south

including Georgia. Near Fort Barrington, on the Altamaha River, they discovered a beautiful tree or shrub, hitherto wholly unknown to botanists. They named it *Franklinia altamaha,* after the great Philadelphian and the river on whose banks it grew. By the laws of nomenclature it should, perhaps, be called *Gordonia.* In 1777 William Bartram, traveling alone, visited the same locality, rediscovered the tree and secured either cuttings or seeds, which were brought back and planted in his garden, within a dozen miles of this spot. The tree had never been found wild before nor has it since. Apparently it has become extinct, except as a cultivated plant (like the Ginkgo). It is an old story in this vicinity. Within five years the trees in Bartram's garden were producing seeds. Not only was a wild species saved from extinction (a most valuable service to science), but our gardens and parks have been enriched with a new and beautiful shrub.

(2) The modern science of Genetics is scarcely forty years old. Its foundation was laid in 1866 by the publication of a paper on Plant Hybrids by the Austrian Monk, Gregor Mendel. Mendel's laws were based on his breeding experiments with the garden pea. Plant breeding was made possible by the discovery of the nature and functions of the organs of a flower, and that plants could be artificially hybridized.

These discoveries were all made by the experimental study of plants *in botanic gardens.*[4] Centuries of study of plants growing wild had not revealed these fundamental conceptions. The existence of a great collection of trees and plants in a botanic garden or arboretum facilitates and stimulates the study of plant life.

(3) The enrichment of American horticulture by the plant explorations of the Arnold Arboretum is well known throughout the world. To this arboretum we are indebted for Thunberg's barberry (*Berberis Thunbergii*), the paniculate clematis (*C. paniculata*), the tree lilac, the Katsura-tree (*Cercidiphyllum*), the climbing hydrangea, the evergreen bittersweet, the Amur cork-tree (*Phellodendron amurense*), and other woody plants, now among the most prized materials for ornamental horticulture.

In Loudon's extended account, in his book just cited, of the exchange of ornamental, timber and fruit trees between different countries—a matter of the highest importance—we learn that this took place largely between private and public arboretums.

Says Loudon, speaking in 1838:

> It would doubtless contribute to the spread all over the world of the trees and shrubs of North America, if one part of them could be seen in a grand national garden at New York, and another in a garden or arboretum at Charlestown; or if the whole could be assembled in one grand park or pleasure ground at Washington.

And then Loudon indulges in a reflection not strictly horticultural:

> If it is desirable for us [he says] that we should assemble in our country the trees and shrubs of every other similar climate, it must be equally desirable that the inhabitants of every other similar climate should possess all those species for which their climate is adapted. . . . The time for believing that the exclusive possession of any benefit contributes to the prosperity or happiness of nations is gone by [a little prematurely optimistic!] the principles of free and universal exchange and intercourse are found to constitute the surest foundation for the happiness of nations.

It took 75 years for Loudon's hope for arboretums in New York, Charleston and Washington to be two thirds fulfilled; how long will it take for his principle of the free interchange of commodities and courtesies between nations to be realized?

It is one of the glories, as well as advantages, of science that it must be international. There is no such thing as American chemistry or American physics or American horticulture—nor French nor German nor English. If horticulture, or any other science, had tried to be 100 per cent. American or 100 per cent. any other country, it would have been a miserable failure, and we should all have been intellectually and spiritually impoverished. Civilization is, after all, an international and inter-racial achievement.

But what opportunities for arboretums lie ahead? Three instances, only, may be cited to illustrate the extent and importance of the problems that confront arboretums in forest pathology only, not to mention other aspects of forestry and arboriculture.

(1) In 1904 a new tree disease known as the chestnut blight appeared in New York City. Within a short time it had destroyed practically all the chestnut trees within a radius of 200 miles. Scarcely a mature tree is now standing; all that are left are threatened with extinction. The financial loss for the entire United States is more than $50,000,000, and the once greatly valued chestnut lumber is no more available. In the face of this calamity foresters are helpless. The only control measure is to cut down all infected trees. The state of Pennsylvania alone has expended hundreds of thousands of dollars in fruitless endeavor to stop the spread of this disease.

(2) In 1909 the white pines of America were threat-

[4] The fact that plants have sex was proved experimentally in a botanic garden by Camerarius, director of the botanic garden at Tübingen, about 1691–94, but this fact was first glimpsed ten years before Camerarius by Sir Thomas Millington, professor of natural philosophy at Oxford University. He suggested that the stamens were the male organs of the flower, and this inference was based on his observations of the flowers growing in the Oxford botanic garden. Likewise, Koelreuter, who produced the first plant hybrids, conducted his experiments in a botanic garden—at Karlsruhe, where he was director.

ened with extinction by the "blister rust," a disease also imported from Europe. The value of the timber-stand that was threatened was estimated at more than $400,000,000. The only way yet known to keep this disease in check is to destroy all the currant and gooseberry bushes within a radius of many miles of any white pine—a drastic and difficult procedure, and only partially possible.

(3) At present, another priceless possession—our American elm, is threatened with extinction by the Dutch elm-disease. The only known way to check the ravages of this menace is to cut down and burn all infected trees as soon as they are discovered. We are as helpless in this respect as the dentists were in the medieval period of dentistry, when the only known remedy for a diseased tooth was to pull it out. The money value of the threatened elms—many millions of dollars—is perhaps exceeded by the esthetic value of these trees in field and park, on street and campus and dooryard.

Surely here are needs not yet adequately met and challenges to any arboretum for a service of the highest scientific and economic importance.

The study of forest pathology is, of course, only one of the opportunities and responsibilities of an arboretum. By cooperating with garden clubs and other horticultural organizations it can render services that are important in fostering a general public interest in all aspects of plant life.

At such an arboretum as this there might, in time, be developed a training school to prepare young men for practical work in dendrology and arboriculture, with special reference to work on college campuses, private estates and the park departments of our cities.

An arboretum also serves to exhibit a rich collection of trees and shrubs, so that people may become acquainted with such material, develop their taste and improve the planting and beautifying of their own grounds. And (of special importance for a college) the presence of an arboretum, like this one at Swarthmore, not only facilitates and enriches the formal instruction in botany, but in a more passive way contributes to the educational atmosphere of undergraduate life.

Sir Frederic Kenyon, in his Romanes Lecture at Oxford, spoke of museums as an integral part of the system of national education, "a part of the nation's contribution to civilization," "a part of the response to the need that man has for quality in his life as well as quantity." And arboretums, being a highly specialized outdoor museum, may make the same kind of contribution to the life of the spirit and the promotion of general culture.

We are living in troubled times. Forces are at work that aim to introduce a new order of things into human life. Their program for realizing Utopia appears to involve the abandonment or destruction of much of the precious heritage of freedom and liberty of life and thought for which the human race has struggled and fought for many generations. No one could seriously question the fact that the content of college education should enable young men and women to understand the pressing problems of the moment, to view them in perspective and to consider dispassionately the possibilities of solution.

But, urgent as these subjects are, they are not the only matters that should be brought to the serious attention of college students. The spontaneous interests of thousands of students are outside the realm of the practical affairs of politics and social science, and the most important problem of our colleges and universities is to help students discover what their major interest in life is and to provide the richest opportunities possible for the cultivation of those interests.

Aside from all questions of the practical aspects of arboriculture and forestry many students will discover in the environment of an arboretum the major enthusiasm of their lives. From the standpoint of education, that is more important than any information that may be learned about trees and shrubs—or economics and history.

The establishment of this arboretum is, *ipso facto*, an enrichment of the cultural opportunities of Swarthmore College.

Some years ago, in another address, I noted how seldom our colleges have utilized their grounds for educational ends. There is no inherent reason why our college campuses should be only parks where the educational plant is located. They might just as well be an integral part of the educational plant—an outdoor extension of the laboratories of botany and horticulture.

And things may be educational without the aid of formal instruction. It is an education in slovenliness to live in an environment of disorder, just as it is an education in esthetics to be surrounded by beauty; lectures on art may help, but they are not essential. If students pass daily through a campus with the trees and shrubs grouped on a botanical basis and attractively labeled, many of them will incidentally, and more or less unconsciously, *absorb* a certain amount of information, and have aroused within them a certain amount of interest in plant life. More than one scientist has received his initial interest and urge by merely strolling through the halls of a museum as a boy.

The idea of an arboretum-campus has been struggling for realization in America for nearly 300 years—from the first decade of Harvard College. Harvard has just celebrated its three hundredth anniversary.

How small the beginnings may be that eventuate in great accomplishment is illustrated by the fact that the second president of Harvard, Dr. Dunster, in his first years, on a salary of £55 a year, was not only charged with all the duties of administration but gave all the instruction. For five days in each week he was occupied with lecturing from 8 A.M. to 5 P.M. His lectures were on such diverse subjects as arithmetic, astronomy, divinity, politics, rhetoric, Aramaic, Syriac, Hebrew and Greek.

His program recalls that of Theophrastus. When did President Dunster prepare his lectures, read examination papers, attend to administration? And *when* did he do his research!

For our purpose this afternoon we note with interest, and perhaps with some surprise that on every Saturday during the spring and fall quarters of the year, from 2 to 3 P.M., President Dunster conducted a botany class, lecturing on the "Nature of Plants." "This," says the historian of Harvard College, "signalizes the inauguration of Botany; a light subject, suitable for hot Saturday afternoons in July and August. . ."!

We are familiar with the opinion, commonly held a generation ago, that botany was largely a subject for girls' finishing schools, but this is the only time I ever saw it characterized as "a light subject," suitable for hours of languor on hot summer afternoons.

Morrison thinks that the phrasing of the title of Dunster's course—"Nature of Plants"—indicates that the teaching consisted in reading to the students some abbreviated edition of Aristotle's *De Plantis,* or possibly Theophrastus's book of similar title.

Morrison also thinks it would be rash to assume that President Dunster adjourned his botany class to the Harvard "Yard" in order to study nature at first hand. Perhaps it would be, for one to whom scientific method was doubtless a closed book, and who had such a heavy schedule of teaching and administration as Dunster had.

However, Dunster's teaching must have been very inspiring, for the laws of Harvard College forbade any student to show a light in his study *before* four o'clock in the morning.

In 1672 Dr. Leonard Hoar became president of Harvard, and is said by Morrison to have had a "broader purpose" for the college than any other president before Eliot. President Hoar referred to himself as an amateur botanist. In a letter to the great chemist, Robert Boyle, he enumerates some of his ambitions for Harvard, and specifies, "A large well-sheltered garden and orchard for students addicted to planting."

Now, after nearly three hundred years, Harvard has the Arnold Arboretum, one of its most important and best known departments. Smith, Wellesley, Mt. Holyoke and several other colleges now have botanic gardens on their campuses; Michigan, Cornell, Pennsylvania and some other universities have arboretums that do not include the campus; but only a few institutions —the University of North Carolina, the Friends School at Westtown (Pennsylvania), and now Swarthmore—have developed their campuses as arboretums or as integral parts of an arboretum.

The advantage, for studying botany or horticulture, of having at hand such a plantation as a botanic garden or arboretum hardly needs to be further emphasized. There is assembled, in small compass, a collection of plants from all over the world—material that could not otherwise be seen except by extensive travel, prohibitively expensive for most students of plant life. Moreover, the plants, trees and shrubs have been arranged in systematic sequence, or on some other botanical basis, and they have been identified and labeled, all of which facilitates the use of the collection for study and instruction.

Such a collection, supplemented by a suitable herbarium and library, and administered by a competent staff of investigators and teachers, with the *esprit de corps* of a body of students, and surrounded by the academic atmosphere of a great educational institution like Swarthmore, can not help but be a stimulus to delightful and profitable study and an important factor in preparation for life work in the field of one's greatest enthusiasm.

These, and more, are the advantages that have been made possible at Swarthmore by the Arthur Hoyt Scott Foundation. It is a wonderful educational opportunity, and I hope that funds will become available with increasing abundance to make possible in this center, so rich in botanical tradition and achievement, the development of a scientific and educational program correlated with a campus-arboretum, and preserving the high standards of scholarship that have always characterized the various departments of Swarthmore College.

This foundation, commemorating the worth-while interests and high ideals of Arthur Hoyt Scott, lover of trees and of Swarthmore, may be made not alone to enrich the undergraduate curriculum of this college, but to serve botanical and horticultural science and education on a national and international scale, to foster a love of beauty, to emphasize the importance of a study of plant life, and to promote an interest in the conservation of our natural resources. The foundation is laid; the superstructure has been begun; the vision, the enthusiasm and the will to accomplish are here in full measure. To paraphrase St. Paul: This college has planted, your Apollos has watered; may God give the increase in full measure of abundance.

OBITUARY

WILLIAM HARDING LONGLEY

DR. WILLIAM HARDING LONGLEY, professor and chairman of the department of biology in Goucher College and executive officer of the Tortugas Laboratory of the Carnegie Institution of Washington, died on March 10, 1937, after a protracted illness. In his passing, zoology has lost one of its keenest students and Goucher College one of its most stimulating teachers.

Dr. Longley was born in Paradise, Nova Scotia, on October 27, 1881. He received the B.A. degree from Acadia University in 1898. After serving for five years as a principal in the public schools of Nova Scotia, he entered Yale, from which he received the degrees of B.A. in 1907, M.A. in 1908 and Ph.D. in 1910. After acting as instructor at Yale for one year, he became in 1911 instructor in biology and associate professor of botany at Goucher College. In 1914 he was made professor of botany and in 1919 professor of biology. In 1917 he succeeded Professor Wm. E. Kellicott as chairman of the department. He received in 1931 the honorary degree of doctor of science from Acadia University. He was a member of Phi Beta Kappa, Sigma Xi and numerous scientific societies.

In 1911 Dr. Longley went to the Dry Tortugas Laboratory of the Carnegie Institution of Washington as collector. While there he became interested in the possibility of using tropical reef fishes as material with which to test experimentally the Darwinian concepts of protective coloration and mimicry. Returning the following summer as investigator, he devoted this and many succeeding seasons to an intensive study of the rôle of color and pattern in the life of the fishes of the tropical reefs. During these years there developed between him and Dr. Alfred G. Mayer, director of the laboratory, a deep intimacy and a similarity of interest which made it but natural that he should be asked, upon the death of Dr. Mayer, to become director of the laboratory and to carry on the excellent tradition of accomplishment established by the latter. Under his leadership, the work of the laboratory grew rapidly, many eminent investigators from this country and abroad finding there a much-needed opportunity.

In order to discover the degree to which color, pattern and the ability to change both color and pattern are of use to the reef fishes, it was necessary to live with them for long stretches of time, to become acquainted with their habits and their ecological relations. Consequently he spent many hours a day under water, using a diving hood, recording observations by means of wax tablets and a water-tight photographic outfit. He thus came to know the tropical reef fishes of the Gulf of Mexico as no other man has ever known them.

The scope of these studies gradually widened until they covered the tropical reef fishes of the world. Under the auspices of the Carnegie Institution, he made several trips to Hawaii and Samoa, and on one occasion spent the better part of a year in a trip around the world, much of the time being spent in the Dutch East Indies. By means of undersea studies, he came to know with more or less intimacy the structure, habits and ecological relations of more than 350 species of Gulf fishes and over 400 species of Pacific fishes. He was also well acquainted with museum material. Under the same auspices, he was able to visit the principal museums of the world and to study the type specimens of most of the described species of reef fishes.

Concerned originally in testing the Darwinian theories of protective coloration and mimicry, his interests gradually spread with the years. He became interested in species, not from the purely taxonomic point of view, but from the standpoint of the student of evolution. This study led to a comprehensive statistical theory of the origin and spread of species, which was his chief concern in later years. As an incident to his study of species, for he never considered it more than incidental, his intimate knowledge of reef fishes in their native habitats as well as of type specimens in the museums led to a profound modification of their classification. He reduced over 20 per cent. of the recognized species of Gulf reef fishes to synonymy, and as a result the surviving species were seen to constitute clearly separable and distinct natural entities.

In his manner of working, Dr. Longley had many of the traits of Charles Darwin. He was his own severest critic, checking and confirming his facts with painstaking care and refusing to adopt his own hypothesis until every other alternative had been satisfactorily disposed of. His extreme caution led him to refrain from publication as long as any uncertainty existed with regard either to data or to the conclusions to be drawn from accumulated facts. Consequently, he published relatively seldom, apart from annual reports in the Year Book of the Carnegie Institution of Washington. At the time of his death he had almost ready for the printer the manuscript of an extensive monograph on the reef fishes of the Gulf of Mexico. This work, richly illustrated with undersea photographs and drawings from life, is a model of thoroughness and accuracy of observation and sets a new standard in the manner in which it emphasizes the necessity of knowing the living organism in its natural habitat. While unfinished, the manuscript is apparently in such a condition that it can be published. Whether his extensive notes on the

Pacific fishes can be utilized is at the present writing uncertain.

Dr. Longley was an inspiring teacher. Due largely to his influence, most of the major students in his department have gone into some form of active biological work. Many of his students have taken doctorates and a goodly number have made, and are making, significant contributions to knowledge. Few teachers in strictly undergraduate institutions have seen as many of their students entering fields of active research as he. His own passionate enthusiasm for research, and his deep personal interest in his students, of which they were keenly aware, made him an unusually successful teacher.

Dr. Longley was known to his colleagues as a man of sound judgment, endowed with more than his share of good hard common sense. He was a practical idealist, combining the highest standards in life and work with a realistic understanding as how best to maintain these standards. He will be missed, not only as an investigator, but as a stimulating and helpful friend and colleague.

In 1908, Dr. Longley married Hazel Fowler Baird. Mrs. Longley and three children survive him.

Ralph E. Cleland

RECENT DEATHS AND MEMORIALS

Dr. William Morton Wheeler, professor emeritus of entomology at Harvard University, died suddenly on April 19 at the age of seventy-two years.

Dr. Albert Potter Wills, since 1909 professor of mathematical physics at Columbia University, died on April 17 at the age of sixty-four years.

The *Journal* of the American Medical Association reports that the Arthur B. Duel Facial Palsy Clinic has been established at the Manhattan Eye, Ear and Throat Hospital in memory of the late Dr. Duel, who founded a clinic for facial palsy in the hospital in 1933 and was in charge of it until his death. Dr. Thomas G. Tickle, a former associate of Dr. Duel, is in charge of the clinic and will offer a course in the surgical technic and treatment of facial paralysis.

A committee headed by Professor Sergent has been appointed to collect funds for a statue of Laënnec to be erected in Paris on a site in front of the Charité Hospital. The amphitheater in which Laënnec taught in the latter institution still exists and the wards in which the discoverer of auscultation first applied this method faced the square in which the proposed statue will be placed.

SCIENTIFIC EVENTS

THE DEPARTMENT OF HEALTH AT YALE UNIVERSITY

The scope of the work of the Yale Department of University Health, which has general supervision of student health, including physical education, definitely increased last year, according to a university bulletin. This increase was especially marked in the medical, surgical and physical therapy departments. There were 21,045 medical consultations; 6,327 surgical consultations and 4,885 physical therapy consultations.

All entering students were tested with an improved form of tuberculin called "purified protein derivative." The total number of undergraduate freshmen tested with tuberculin was 846, of whom 42.4 per cent. reacted positively. The number of entering students from all other departments was 608, of whom 56.9 per cent. reacted positively. For the combined number the percentage of positive reactors to tuberculin was 48.4. The comparable figures for the year 1931–32 were 53.9 positive for freshmen, 71.7 positive for graduate students, or a combined percentage of 62.1 positive. The bulletin points out that "This marked drop in positive reactions to tuberculin presumably indicates a lessened exposure to which this group has been subjected, and is consonant with results in other universities where this procedure is carried out."

Under the guidance of the department, 3,780 students last year took exercise for a total of 214,417 periods. The freshman program included instruction in correct body mechanics, optional sports and exercises as well as tests and instruction in leisure skills and games. The results of the tests given in recreational sports showed that 810, or 92 per cent., could swim; 316, or 37 per cent., could play golf, and 368, or 44 per cent. could play squash. All the 846 members of the freshman class, with the exception of sixteen who were excused by the department, could swim before the year was over.

Following the orthopedic examinations of the freshman class, 533 men were assigned to take corrective exercises. Before the end of the compulsory period, 66 per cent. of the total group were released. Of the entire number taking the corrective exercises, only a few more than 10 per cent. failed to pass the final examination. Supplementing the orthopedic examination a postural photograph of individuals with poor body mechanics is taken before any corrective work is given. Upon release from a corrective class, another photograph is taken to show improvement over the initial posture.

REORGANIZATION OF THE DEPARTMENT OF FORESTRY AT CORNELL UNIVERSITY

PURSUANT to suggestions made by the Board of Regents of the University of the State of New York and the State Department of Education, the trustees of Cornell University and of the New York State College of Forestry at Syracuse University have recently taken action that will result, after July 1, in changes in the teaching programs in the field of conservation offered by these two institutions.

After July 1, according to an announcement made by Dean Carl E. Ladd, of the New York State College of Agriculture at Cornell University, all instruction in professional forestry, both graduate and undergraduate, offered under state auspices, is to be concentrated in the New York State College of Forestry at Syracuse, and similarly all professional instruction in wildlife conservation and management in the New York State College of Agriculture at Cornell.

As regards forestry this action was foreshadowed when in February, 1933, the Board of Trustees of Cornell University ordered that undergraduate instruction in professional forestry be terminated in June, 1936, with the graduation of the classes of undergraduate students of professional forestry then in residence. With the granting, at the end of the present college year, of the degree of master of forestry to the graduate students in forestry now at the university, Cornell will cease to confer that professional degree and the department of forestry will no longer receive either graduate or undergraduate students of professional forestry.

The department of forestry will thereafter limit its instruction to courses, non-professional in character, designed to round out, as to forestry, the programs of students of agriculture or of wildlife conservation and management. The extension work of the department of forestry will be continued as in the past, following the general program which has been actively pursued in recent years.

To serve students in any department of the university who are especially interested in farm or woodland forestry, or who desire general information about forestry and the broader aspects of conservation, including wildlife conservation in relation to forestry, the courses covering these subjects will be continued. Graduate students in fields allied to forestry may elect to work in subjects other than professional forestry under the direction of members of the staff of the department of forestry as candidates for the degrees of master of science and doctor of philosophy.

The development of the research forest properties, and certain phases of other research work in forestry are continued. Research in forest soils, under Professor R. F. Chandler, Jr., is not affected by the reorganization, nor are the opportunities for graduate study of forest pathology, or of the fundamental aspects of the biological sciences in allied departments of the university.

In connection with this reorganization, Professor Cedric H. Guise has been transferred from the department of forestry to the office of the director of resident instruction of this college, where he will serve as professor of personnel administration. His transfer took effect on February 15.

SPECIAL SUMMER PROGRAM ON SPECTROSCOPY AND ITS APPLICATIONS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A FIFTH spectroscopy conference will be held at the George Eastman Research Laboratories of the Massachusetts Institute of Technology on July 19, 20 and 21, repeating to a considerable extent the type of program presented at the conferences held during the past four summers. Reports will be given by spectroscopists from university and industrial research and analytical laboratories and by biologists, metallurgists, geologists, chemists and physicists who have found spectroscopic equipment useful in their investigations.

Morning and afternoon meetings will be held during all three days. A program of papers and discussions is being prepared on analysis of materials by the emission spectrum, absorption spectrophotometry, photographic photometry, biological and chemical effects of spectral radiation and industrial applications of spectroscopy. Copies of the detailed program of the conference will be sent to any one interested, but as the attendance at the conference will this year be limited to two hundred, those expecting to attend from a distance are urged to signify in advance if possible their intention of attending. No fee is charged in connection with the conference. Its object is to promote cooperation between workers in various scientific and industrial fields.

The usual summer courses on practical and applied spectroscopy will be offered at the institute between June 14 and July 24. The invitation of recent years is being extended to qualified investigators to make use during the coming summer of the spectroscopic facilities of the institute in connection with their researches. Members of the conference will be expected to be responsible only for any expensive equipment required specially for their own investigations which is not already available in the laboratory.

Requests for fuller information regarding the conference, including titles of the papers to be presented, and for data regarding the summer courses and spectroscopic research, should be addressed to Professor G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Mass.

THE MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY AT PHILADELPHIA

THE seventy-first meeting of the American Electrochemical Society will be held at the Hotel Benjamin Franklin, Philadelphia, on April 28, 29 and 30.

One of the main sessions will be devoted to the electrochemical phenomena which have been observed in living cells. Among those who will participate in the discussion are: Professor A. H. Abramson, of Columbia University; Messrs. W. J. V. Osterhout, L. Michaelis, D. A. MacInnes and L. G. Longsworth, of the Rockefeller Institute for Medical Research, and Professor E. J. Cohn, of the Harvard Medical School.

Speakers at a session on the problems of industrial catalysis will be: P. K. Frolich, of the Standard Oil Development Company; V. N. Ipatieff, of the Universal Oil Products Company; A. T. Larson, of the du Pont Company; H. S. Taylor, of Princeton University, and Messrs. P. H. Emmett and S. Brunauer, of the U. S. Department of Agriculture.

There will be also technical sessions on electrode phenomena in aqueous solutions and on organic electrochemistry.

On Thursday evening Dr. Detlev W. Bronk, since 1929 Johnson professor of biophysics at the University of Pennsylvania, will give an address on "Electrical Methods in the Study of Nerve and Muscle." The retiring president, Dr. Duncan A. MacInnes, of the Rockefeller Institute for Medical Research, will deliver his address, entitled "The Contribution of Willard Gibbs to Electrochemistry," on Friday evening. At the luncheon on Saturday Dr. H. C. Rentschler, of the Westinghouse Lamp Company, will give an address entitled "Photo Cells."

Friday morning will be devoted to visits to industrial firms, including the Edward G. Budd Manufacturing Company and the Leeds and Northrup Company, followed by a luncheon given by the latter company.

THE RESEARCH FOUNDATION OF THE OHIO STATE UNIVERSITY

IN SCIENCE for November 27 an account is given of the organization of the Ohio State University Research Foundation. The corporation is not for profit and none of the officers of the corporation nor of its members receive remuneration in any form. Its object is to bring about a closer cooperation between the university and industry, particularly in making the laboratory and research facilities of the university of greater helpfulness in solving the problems of industry.

Officers elected to initiate the foundation are: George W. Rightmire, *president;* Carl E. Steeb, *treasurer;* Hurlbut S. Jacoby, *secretary and director.* All officers are on the university staff, Dr. Rightmire being president, Mr. Steeb, business manager, and Mr. Jacoby, director of industrial research. The directors are: Charles E. MacQuigg, New York City; Thomas Midgely, Jr., Detroit; Charles F. Kettering, Detroit; J. L. Morrill, Columbus; Harry A. Toulmin, Jr., Dayton; Arno C. Fieldner, Washington, D. C.; Charles F. Michael, Bucyrus; E. E. Ware, Cleveland; James F. Lincoln, Cleveland; Harry A. Caton, Coshocton, and Julius F. Stone, Mr. Rightmire, W. W. Charters, John F. Cunningham and William McPherson, Columbus.

The foundation has a membership of fifty-five, including ten councilors as follows: from national industries, ten Ohio State alumni members, ten councilors from Ohio industries, members of the university board of trustees, deans of the various Ohio state colleges, directors of campus research bureaus and the director of the Ohio Agricultural Experiment Station at Wooster.

National councilors are: Willard Chevalier, McGraw-Hill Publishing Co., New York; L. W. Chubb, Westinghouse and Manufacturing Co., East Pittsburgh; Saul Dushman, General Electric Co., Schenectady; Harvey Fletcher, Bell Telephone Laboratories, New York; C. F. Hirshfeld, Detroit Edison Co., Detroit; C. F. Kettering, General Motors Corporation, Detroit; Henry G. Knight, Bureau of Chemistry and Soils, Washington, D. C.; C. E. MacQuigg, National Carbide and Carbon Corporation, New York; Thomas Midgely, Jr., Ethyl Gasoline Corporation, Detroit; Robert B. Sosman, U. S. Steel Corporation, Kearny, N. J.

Industrial councilors are: R. K. Brodie, Procter and Gamble Co., Ivorydale; Harvey Firestone, Jr., Firestone Tire and Rubber Co., Akron; William V. Fisher, Hocking Glass Company, Lancaster; W. J. Harshaw, Harshaw Chemical Co., Cleveland; W. T. Holliday, Standard Oil Co. of Ohio, Cleveland; Charles R. Hook, American Rolling Mills Co., Middletown; J. F. Lincoln, Lincoln Electric Co., Cleveland; Charles F. Michael, Ohio Locomotive Crane Co., Bucyrus; Alexander Thomson, Champion Paper and Fibre Co., Hamilton; E. E. Ware, Sherwin-Williams Co., Cleveland.

Alumni members of the foundation are: Firman E. Bear, American Cyanamid Co., New York; D. J. Brumley, American Railway Engineering Association, Chicago; H. R. Drackett, Drackett Co., Cincinnati; A. C. Fieldner, U. S. Bureau of Mines, Washington, D. C.; William N. King, New York Central Railroad, Cleveland; Roy D. McClure, Henry Ford Hospital, Detroit; J. L. Morrill, Ohio State University, Columbus; F. H. Riddle, Champion Spark Plug Company, Detroit; G. F. Schlesinger, National Paving Brick Association, Washington, D. C.; H. A. Toulmin, Jr., Toulmin and Toulmin, attorneys, Dayton.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the National Academy of Sciences will be held in Washington on April 26, 27 and 28. The evening lecture will be given by Dr. George H. Whipple, of the University of Rochester, his subject being "The Romance of Hemoglobin."

DR. ERICH TSCHERMAK has been elected a correspondent of the Academy of Sciences, Institute of France, in the section of rural economy. He fills the place left vacant by the death of Theobald Smith.

THE Pasteur Medal of the French Society of Clinical Biology has been awarded to Professor L. van Itallie, of the University of Leiden.

THE London *Times* announces that the council of the Iron and Steel Institute has awarded Bessemer gold medals for 1937 to Colonel N. T. Belaiew and to M. Aloyse Meyer. Colonel Belaiew, of Paris, a former pupil of Professor Tschernoff, of the Military Academy, Petrograd, is an authority on metallurgy. M. Aloyse Meyer, of Luxemburg, is an honorary vice-president of the Iron and Steel Institute, and is known as the head of the Société Anonyme Arbed, the Luxemburg combine, and the second largest iron and steel company in Europe.

DURING the April meeting of the International Council of Scientific Unions in London an honorary degree will be conferred by the University of London on the president of the council, Professor N. E. Nörlund, director of the Geodetic Institute of Copenhagen.

Nature states that the Central Executive Committee of the U.S.S.R. conferred the Order of Lenin on Professor A. N. Bach, on the occasion of the fiftieth anniversary of his scientific activity, for his work on the chemistry of photosynthesis, respiration and enzyme action. Professor Bach celebrated his eightieth birthday on March 17.

DR. HENRY V. HOWE, director of the School of Geology of the Louisiana State University, was appointed secretary-treasurer of the Society of Economic Paleontologists and Mineralogists at the recent meeting in Los Angeles.

DR. C. S. MUDGE, associate professor of dairy industry and associate dairy bacteriologist in the experiment station of the University of California College of Agriculture at Davis, was elected at the San Francisco meeting chairman of the Western Branch of the Society of American Bacteriologists. Dr. Mudge succeeds Dr. Paul J. Beard, of Stanford University. He will have charge of the arrangements for the meeting of the national organization in San Francisco next year.

DR. ROBERT P. WALTON, assistant professor of pharmacology at the School of Medicine of Tulane University, has been appointed professor and head of the department of pharmacology of the School of Medicine of the University of Mississippi.

DR. ROWLAND W. LEIBY has become assistant professor of entomology in the extension department of Cornell University, to fill the vacancy caused by the death on January 11 of Professor Cyrus R. Crosby.

VLADIMIR MISSIURO, professor at the Central Institute of Physical Education of the University of Warsaw, has been appointed research associate in the Harvard Fatigue Laboratory for the current academic year. Dr. José H. Aste-Salazar has been appointed research assistant.

DR. LINDA B. LANGE, associate professor of bacteriology at the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed professor of bacteriology and immunology at the Woman's Medical College of Pennsylvania, Philadelphia.

THE department of mining and metallurgy of the Massachusetts Institute of Technology has been divided into two distinct fields of professional education; the department of mining engineering will be administered under the direction of Professor W. Spencer Hutchinson. This department will include the course in petroleum production. There will be established a new department of metallurgy, which will be directed by Dr. Robert S. Williams, professor of physical metallurgy. This department will include the course in ceramics.

AT the College of Engineering of the Carnegie Institute of Technology, beginning next autumn, courses in chemical engineering will be administered under two separate departments instead of under one as at present. Dr. Thomas R. Alexander, associate professor of inorganic chemistry, will become acting head of the department of chemistry, and Dr. Warren L. McCabe, professor of chemical engineering, will be the head of the department of chemical engineering.

PROFESSOR A. E. TRUEMAN, Chaning Wills professor of geology in the University of Bristol, will succeed Professor E. B. Bailey in the chair of geology at the University of Glasgow. Dr. Bailey was recently appointed director of the Geological Survey of Great Britain.

DR. N. K. ADAM, research chemist in Imperial Chemical Industries, Ltd., has been appointed professor of chemistry in University College, Southampton.

DR. AARON L. TREADWELL, since 1900 head of the partment of zoology of Vassar College, having ched the age of seventy years, will retire in June. will be succeeded by Dr. Rudolf T. Kempton, now istant professor in the department of biology at inceton University.

DR. WALTER L. JENNINGS, head of the depart-nt of chemistry and chemical engineering at the rcester Polytechnic Institute, will retire from teach-g at the end of the current academic year. He will succeeded by Dr. Frederic R. Butler.

AT Columbia University Dr. Leslie C. Dunn, pro-sor of zoology, and Dr. James W. Jobling, professor pathology, have been elected members of the uni-sity council. Dr. Dunn will serve as chairman of committee on instruction.

DR. PAUL POPENOE has resigned from the Human tterment Foundation at Pasadena, Calif., of which has been secretary since its organization, and here-er will devote all his time to the Los Angeles Insti-te of Family Relations, of which he has also been neral director from its incorporation seven years o.

PROFESSOR AUGUSTO BONAZZI, for a number of years nnected with the Estacion Experimental Agronomica Santiago de las Vegas, Havana, has recently as-med his work as director of research for the Depart-nt of Agriculture and Animal Industry at Caracas, nezuela.

DR. WALTER B. CANNON, of the Harvard Medical hool, is honorary chairman of the Greater Boston mmittee to Aid Spanish Democracy. Sponsors of movement include President Karl T. Compton, of Massachusetts Institute of Technology; President niel L. Marsh, of Boston University, and Dr. John bert Cousens, president of Tufts College.

IN response to a request for an opinion on "The ace of Science in National Planning," by Senator bert J. Bulkley, chairman of the United States nate Committee on Manufactures, the American stitute sponsored a discussion at the Chemists' Club, w York City, on April 22. Dr. Willis R. Whit-y, of the General Electric Company; Waldemar empffert, science editor of *The New York Times;* r. George Baehr, trustee of the New York Academy Medicine; Julius H. Barnes, formerly chairman of U. S. Chamber of Commerce, and others were sent and led the discussion.

DR. E. V. MCCOLLUM left on April 2 for Geneva. represented this country in nutrition at a meeting the Mixed Committee of the Health Section of the ague of Nations, which held sessions from April to 17.

AT the University of Michigan, leave of absence during the first semester, 1937 to 1938, has been given to the following members of the faculty: Dr. Ermine C. Case, professor of historical geology and paleontology; Dr. Samuel A. Graham, professor of economic zoology; Dr. Burton D. Thuma, assistant professor of psychology; Dr. Lewis E. Wehmeyer, assistant professor of botany. Leave of absence for the entire year has been accorded to Dr. Otto Laporte, associate professor of physics; to Horace W. King, professor of hydraulic engineering, and to Stephen S. Attwood, associate professor of electrical engineering.

DR. HUGO OBERMAIER, professor of prehistory at the University of Madrid, recently lectured before the German Archeological Institute at Rome.

PROFESSOR A. A. ALLEN, of Cornell University, addressed a joint meeting of the Washington Academy of Sciences and the Biological Society of Washington on April 8. The lecture on "American Ornithology, Past and Present," was illustrated by lantern slides and motion pictures with sound recordings.

SIGMA XI lectures on "Internal Secretions in Reproduction," by Dr. Edgar Allen, professor of anatomy at Yale University, were given at Tulane University, the University of Alabama, Virginia Polytechnic Institute and the University of Maine from March 31 to April 8.

DR. C. V. ARIENS KAPPERS, director of the Central Institute of Brain Research of Amsterdam and professor of comparative neurology at the university, addressed the third-year class of the Long Island College of Medicine on April 7. His subject was "The Autonomic Center of the Hypo-Thalamus."

THE eighth annual meeting of the American Association of Physical Anthropologists was held at Cambridge, Mass., on April 8, 9 and 10. The annual public address was delivered by Dr. H. L. Shapiro, of the American Museum of Natural History, the subject being "The Pitcairn Islanders." At the dinner Professor Wm. F. Petersen, of the University of Illinois, gave an illustrated address on "Environmental Effect and Organic Differentiation."

THE annual meeting of the American Association of Pathologists and Bacteriologists will be held in Atlantic City, N. J., on May 3 and 4, 1938, in conjunction with the Congress of American Physicians and Surgeons.

THE third annual meeting of the New York Geographical Association will be held on May 1. There will be a series of papers during the morning session, from nine-thirty to twelve o'clock; a field trip in the afternoon, starting at two o'clock; and a banquet in

the evening at six-thirty. Professor Erwin Raisz, of the Institute of Geographical Exploration at Harvard University, will be a guest speaker. The special committee on the status of geography in the schools of New York State will present its report.

THE Division of Biology of the University of Georgia announces a meeting on May 7 and 8 of the biologists of the southeastern states at Athens, Georgia. Papers on original research and accounts of biological work in southeastern institutions will be presented. The principal address will be given by Dr. L. O. Kunkel, member of the Rockefeller Institute for Medical Research, who will speak on some of the rec developments in virus research.

THE Missouri Public Health Association will h its thirteenth annual meeting on April 29 and 30 the Kentwood Arms Hotel, Springfield. A progr of particular importance to the public health inter of Missouri will be presented. Papers on tubercul cancer, venereal diseases, maternal welfare, cripp children's service, oral hygiene and malaria are amo those that will be given. The final paper which w be given pertains to the future of public health Missouri under the Social Security Program.

DISCUSSION

RUBBER PRODUCTION FROM CASTILLA AND HEVEA

CAUCHUC, guttapercha, balata, chicle and guayule belong to a series of organic materials sharing such properties as plasticity, resilience and tensile elasticity, dissolving in ether, chloroform, benzol and other liquid hydrocarbons, combining readily with sulfur and the halogen elements, but otherwise inert. No general function in the plant economy has been demonstrated, but the various forms of rubber may be viewed as excretory products and associated with resins, tannins and lignins. As with sugar from cane and beet, rubber of the same nature is obtainable from the Castilla or Central American rubber tree, and from the Hevea or Para rubber tree of Brazil, cultivated in the East Indies, although the trees belong to unrelated families and different methods of extraction are required.

Many kinds of rubber-bearing trees, vines and shrubs have been exploited in the wild state, but only three systems of cultural production have been worked out, one with manual tapping of the Hevea tree, the others with mechanical extraction of guayule and gutta-percha. The mechanical processes are definitely unsuited to the thin Hevea bark, but may be adapted to the thicker latex layer of the Castilla tree. Both trees have been introduced in southern Florida and have reached the stage of flowering and seeding, so that local tests of cultural behavior and methods of extraction may be made.

The special value of Hevea as a plantation tree lies in its system of microscopic latex tubes branching and anastomosing as a continuous network through the inner bark, seeping the creamy fluid to a single cut, replenishing the wound area and restoring the bark pressure. Tapping is repeated by paring the rim of the cut, with the latex supply becoming more liquid and the flow increasing in successive days, the so-called "wound response." The method of wound renewal was discovered by Ridley at Singapore in 1889 and led to commercial planting in 1896, twenty years after Wi ham took the seeds from Brazil.

Castilla has simple latex tubes, not branched or co nected, so that the Ridley tapping method does n apply, but the latex of Castilla is more abundant a was much easier to collect by the native metho though the trees were soon exterminated. Casti was tapped with many cuts, in Mexico by climbi the trees and gashing the bark obliquely, in So America by felling and circling the trunks. Seve pounds of rubber were obtained, 30 to 50 pou from large trees being credibly reported, though o a small part of the latex is forced out by the lo pressure.

An oxidizing enzyme in the sap of Castilla blacke and softens the rubber to a sticky paste, but simp heat treatments avoid such damage. Even in lo lying in the sun the enzyme may be destroyed, and t latex then coagulates in pale elastic threads th separate readily from decaying bark, as in retting f mechanical extraction. Small drops of pure la sometimes exude when "scrap rubber" is pulled fr tapping cuts and coagulate without discoloring. C tilla latex corked in glass bottles shows no visi changes, and was the "liquid rubber" brought fr Central America for the early experiments in Engla by Hancock and Faraday, in 1822 and 1826. Recor of Castilla go back to Bernardino de Sahagun, w reached Mexico in 1529 and wrote of "ulli" as a bla elastic resin with many medicinal uses, and made in bouncing balls.

Many reference works convey the impression Castilla being confined to Central America and Mexi whereas even greater areas were occupied in So America, from Panama through Colombia, Ecuad Peru, Bolivia and Brazil, including practically t entire range of *Hevea brasiliensis* in the Amazon v ley, to Matto Grosso and Para. When Richard Spru reached Brazil in 1849 commercial tapping of Hev was "limited to the immediate environs" of Para, b

few years of rising prices turned thousands of people gathering rubber "nearly throughout the Amazon its principal tributaries." Spruce learned of an lier period when the rubber trees had been cut n, and supposed that a discovery had been made, obtaining more rubber "by successive tappings of same tree," but a recent transition from Castilla is icated, and some of the up-river tribes still did not w of rubber being obtained from Hevea. Exports Castilla rubber from eastern Peru, previously car- over the Andes, began to move down the Amazon 1853, as Schurz has recognized, and "caucho" still es in commercial quantities from many outlying icts in Brazil.

The discovery of Hevea often is dated from 1736 en the French astronomer La Condamine landed Manta and traveled to Quito through the Pacific st province of Esmeraldas where the elastic resin ed "caoutchouc" was obtained, but from the meth- of collecting the latex and forming long rolls of ber to burn as candles or torches, the trees could have been Hevea. West of the Andes no Hevea been found, but Castilla still grows in Esmeraldas in the upper Amazon valley, where rubber-gather- apparently was in progress in 1743, when La Con- mine went down from Quito. The early Castilla ustry carried the Peruvian name *caucho* eastward oss Brazil, and later the Portuguese name for vea rubber, *borracha,* spread westward from Para. en in Brazil it appears that Castilla was the prin- al source of rubber to the middle of the last cen- y, only a few decades before Hevea was carried to East Indies.

Pioneer plantings of Castilla in southern Mexico re dated as far back as 1867 by Olsson-Seffer, and l older planted trees were found around Pichucalco Collins and Doyle. Larger Castilla projects were mulated by developments with Hevea in the East dies, before the radical differences in the latex sys- ns of the two trees were appreciated. By 1908 more n a hundred thousand acres of Castilla had been nted in Mexico and Central America, which soon ame a total loss, estimated at thirty to fifty million lars. Interest in Castilla lapsed completely, leaving ny plantations to grow up as forests, though some these may yet serve in working out mechanical thods of separating the rubber from the bark and king the wood into paper or other by-products. mbering the logs to the mill may be the only labor uired in Castilla forests, volunteer replacement ng indicated by abundant undergrowth of seedling es.

Planting of rubber reserves has been urged for nomic and military reasons, and large denuded as in southern Florida need to be reforested to reduce the fire and frost hazards. Castilla is an ornamental tree, better adapted than Hevea for growing in open places, shading out grass and mulching the soil surface. Even as a nurse-crop for Hevea, the planting of Castilla might prove worth while. Cuttings and seedlings grow rapidly, and hurricane hazards would be less than with Hevea, since the rubber of broken or uprooted trees could still be extracted.

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ROOF FALLS IN MINES

An investigation into the number of accidents resulting from roof falls in Pennsylvanian coal mines showed an annual distribution with maxima in the early spring and in the summer. The first maximum coincides with a high ground-water table in the overlying strata. The summer maximum occurs during those months in which the moisture contained in the ventilating air condenses in the mine because of lower temperature underground. The roof rocks expand under the influence of moisture, and it is suggested that this expansion gives rise to an increased number of roof falls, with the consequence of higher accident rates. The moisture expansion of rocks corresponds closely to the dangerousness of various types of roof rocks. Preliminary measurements gave the following linear expansions for rocks when wetted to saturation with water:

Brittle shale	3×10^{0}	per cent.
Solid shale	5×10^{-2}	" "
Sandy shale	1.2×10^{-2}	" "
Sandstone	9.7×10^{-3}	" "
Limestone	$< 1 \times 10^{-4}$	" "

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THE OLDEST AMERICAN FOSSIL ECHINOID

Professor Herman L. Fairchild, of Rochester, N. Y., has brought to my attention a notice in the *Cornell Alumni News* (Vol. 37, No. 28, p. 2, May, 1935) concerning two specimens of *Lepidechinoides ithacensis,* purported to be the oldest fossil echinoids ever found in America. These were found in Devonian rocks in the vicinity of Ithaca, N. Y. An older specimen, *Koninckocidaris silurica* Jackson, dates from the Silurian. This fossil was found in 1908 by Professor A. W. Giles, who was at that time studying under Professor Fairchild. It was collected from the Rochester shale about 10 feet above the Irondequoit Limestone, in the Genesee ravine at Rochester, N. Y. The specimen shows an internal view of the dorsal portion

and according to Jackson[1] is "beautifully preserved. The holotype with two additional fragmentary pieces is in the collection of the University of Rochester, at Rochester, New York." To quote Professor Fairchild,[2] who also figured the specimen, "The fragment of the test or shell of a sea-urchin (Fig. 44) found in ravine below Smith Street is the oldest echinoid as found in America." (Fig. 44 should read Fig. 45).

J. T. SANFORD

WICHITA FALLS, TEXAS

REPORTS

THE BANTING RESEARCH FOUNDATION

A RECENT report of The Banting Research Foundation shows that, in all, twenty-two different grants were distributed to workers in the laboratories of the universities throughout Canada during the year 1935–1936. A number of them were for comparatively small sums. For the first time in the history of the foundation a larger number of grants was made to workers in the University of Toronto than to other universities, and yet more grants were refused applicants in Toronto than in other universities. This is probably to be explained by the fact that the financial depression has perhaps affected the University of Toronto less than some of the other universities, though it has had the effect of increasing the number of well-qualified men who are unable to find posts and who consequently make application to the foundation to give them the means by which they can carry on their investigations. It is to be hoped that the raising of the depression will be followed by a more equitable distribution of the grants.

As a result of a grant made to Dr. A. C. Abbott and Dr. James Prendergast, of the University of Manitoba, the careful study of the effect of pregnancy on the state of the thyroid gland was published. The grant to A. J. Cipriani, of McGill University, was continued in order to enable him to complete his study of the methods of electrical recording of heart and respiration rates. The summer grant made to B. K. Coady and D. L. MacIntosh, of Dalhousie University, following small grants made in previous years, resulted in the publication with Professor Mainland of a series of four papers dealing with the character and counts of white blood cells with proper statistical analysis of their variation. The grant to K. A. Evelyn, of McGill University, was continued for another year in order to make clinical application of his method of photo-electrocolorimetry. The description of this apparatus has now been published and already various laboratories have adapted it for use, and there is no doubt that a valuable tool has been put in the hands of biochemical workers. Papers on the clinical application of the instrument are already in press.

A grant to Dr. L. Farber, of the University of Toronto, enabled him to make the preliminary ste in a study of the metabolism of certain of the inf tive bacteria. A grant to Dr. A. W. Ham, of t University of Toronto, enabled him to complete h study of the histological changes produced by chro vitamin C deficient diet. This paper is ready f press. A grant to C. O. Hebb, of McGill Universi resulted in a paper showing the relationship betwe external pancreatic secretion and the glucose conte of the blood stream. A grant made to A. H. Smith, of the University of Toronto, led to a min paper dealing with the anesthetic effects of some su stituted furans and the development of a method electrical recording of pulse pressure. Grants ma to Professor L. Irving and K. M. Robertson, of t University of Toronto, enabled further progress be made with the study of the effect of the carb dioxide anhydrase, particularly in regard to the pr duction of bone. The grant made to Dr. S. H. Jac son, of the University of Toronto, enabled a stu to be made of the effect of skin infections on t glucose tolerance of animals fed both a high and low carbohydrate diet. This material is also rea for press. A grant to Dr. E. M. Macdonald, of t University of Toronto, for the study of the transm sion of immunity to the infant, is making progre A grant to C. B. Stewart, of Dalhousie University, f a study of the accuracy of percussion has enabled h to gather a sufficient number of cases for a statistic study. A grant made to Dr. T. S. Perrett, of t University of Toronto, enabled further progress to b made on the effect of heparin on the prevention thrombosis. A grant made to B. Schachter, of t University of Toronto, working under Professor G. Marrian, enabled them to publish a short paper on t oestrogenic substances in mares' urine, which sho that there is less variation in free and combined su stances during pregnancy in this species than occ in man. A grant made to Dr. M. C. Watson, of t University of Toronto, has led to the publication the effects of sex hormones (supplied in part by Pr fessor Marrian) on the disturbances of the menstru cycle. A grant made to Dr. F. Smith, of McGill Un versity, has led to the publication of a paper pointi

[1] Robert Tracy Jackson, Boston Society of Natural History, Mem. 7, pp. 285–6, 1912.

[2] Herman Leroy Fairchild, "Geologic Story of the Genesee Valley and Western New York." Published the author. pp. 51–2, 1928.

out that strains of pneumococci exist which can grow under anaerobic conditions. A grant made to Dr. S. Weinstein, of the University of Toronto, led to the publication of a paper on the purification and assay of one of the sex hormones obtained from human urine during pregnancy. The grant to Dr. J. K. W. Ferguson, of the University of Western Ontario, for apparatus enabled him to complete a study of the carbamic compounds which are so important in the transport of carbon dioxide in the blood stream; a study of very considerable physiological importance. A small grant was made to Dr. M. J. Wilson, of the University of Toronto.

V. E. HENDERSON
D. T. FRASER
Honorary Secretaries

SPECIAL ARTICLES

NEW RECORDS IN HUMAN POWER

FIVE young men of international renown in distance running have been examined recently in this laboratory. In the group were: Lash, who within the past year has established new world's records in the 2-mile run, indoors and out; Cunningham, who holds world's records in the mile run, both indoors and out; San Romani and Venzke, milers on the U. S. Olympic team, who, with the fifth man, Fenske, have run the mile in near world's record time. All the men were in good running form at the time of the experiments.

Observations were made on the runners during rest and in four grades of work. The work of the first three grades was on a motor-driven treadmill: (1) a 15-minute walk at 5.6 kilometers per hour up an 8.6 per cent. grade; (2) a 5-minute run at 11.3 k.p.h. on the same grade; (3) a 5-minute run at 18.7 k.p.h. on a 4.0 per cent. grade. The fourth form of work was actual racing in an indoor track meet on February 13; five minutes after each man's race, venous blood was drawn for analyses.

The blood of these runners is like that of untrained man. The alkaline reserve, defined as the vols. per cent. of CO_2 in oxygenated blood at $pCO_2 = 40$ mm, averaged 48.1 as compared with 48.0 in a group of untrained men. The concentration of hemoglobin in blood and of proteins in plasma were within the limits observed in untrained man. The oxygen-combining capacity after the races ranged from 22.5 to 24.5 vols. per cent. in Cunningham, Venzke and Lash. The respective increases in the races were 7.6, 8.2 and 13.2 per cent. Each observed increase in oxygen capacity closely corresponds to the increase calculated from the observed change in plasma protein on the assumption that no protein leaves the circulation. The plasma chloride in rest and after races was normal, except for Lash, whose chloride shifted from 106.1 m.-eq. per liter in resting plasma to 99.0 after the race in which he broke the world's record for the 2-mile run. The races caused blood lactic acid to rise from 10, 16 and 9 mgm per cent. in rest to 116, 134 and 150, respectively, in Lash, Cunningham and Venzke.

The ratio $\frac{\text{residual air}}{\text{total lung volume}}$ averages 0.288 in the 5 runners and 0.285 in 11 non-athletic young men measured in this laboratory. The average vital capacities in the 2 groups are 5.36 and 4.74 liters, respectively. Expressed in liters per m of body height, the averages are 3.03 liters, ranging from 2.85 to 3.52, in the runners, and in the other group 2.73, ranging from 2.27 to 3.05. Hurtado[1] found an average of 2.72 liters per meter of height in 50 young men.

The maximum ventilation of San Romani, Venzke and Lash, the only runners who went through the hardest grade of work in the laboratory, averaged 113 liters per minute, as compared to 98 liters per minute of 99 other subjects in maximum work. The ratio $\frac{\text{tidal air}}{\text{vital capacity}}$ is practically the same in both groups, averaging 0.458 and 0.464, respectively. The greater ventilation in the runners was due principally to their average respiratory rate of 48, the rate of the untrained being 44. The tidal air of the runners was 2.38 liters with the untrained 2.25 liters. For a given oxygen intake the runners' ventilation was about 12 per cent. less than that of the other subjects.

In the walk at 5.6 k.p.h. the oxygen intake of the 5 runners averaged 1.0 liter per m^2 body surface and the blood lactic acid, 13.4 mgm per 100 cc blood; in 8 untrained young men the averages were 0.99 and 19.1. The similarity of oxygen intake means that in this sort of activity the efficiency is about equal, but the lower lactic acid level in the runners reflects their superiority of oxygen supply to tissues.

Oxygen intake and blood lactate in the harder grades of work are shown in Fig. 1. It will be noted that the runners adapted themselves quite readily to the speed by attaining relatively high oxygen intake. They kept the lactic acid at a fairly low level and finished the run with comparative ease. In this run all the untrained men were compelled to supply a considerable fraction of the energy anaerobically. Thus they accumulated more lactic acid, and only 2 were able to continue for the full 5 minutes. The measurements recorded in this run probably represent maxi-

[1] A. Hurtado and C. Boller, *Jour. Clin. Invest.*, 12: 793, 1933.

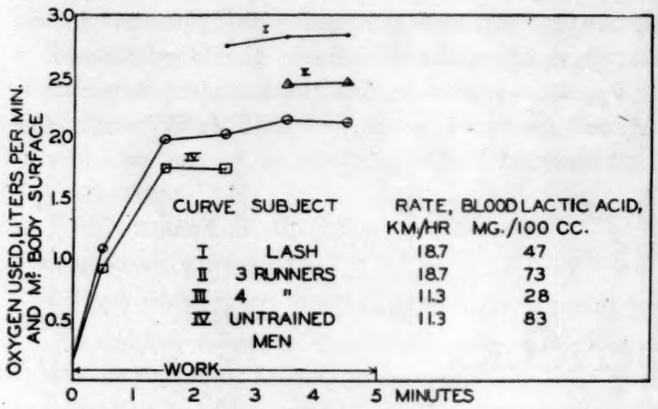

FIG. 1

mal levels of metabolism in all individuals except the runners. Skill is no doubt a factor in the easy adaptation of the runners, but since we did not measure oxygen debt we have no actual measurement of the total energy requirements of the men. When 3 of the runners ran for 5 minutes at 18.7 k.p.h., a task which brought lactic acid up to about the same level as that found in the other men in their maximal work, the runners in all cases elevated their oxygen intake even more, and in 2 of the cases probably reached their maximums. One of the most remarkable observations in the entire experiment was Lash's consumption of 4.96, 5.08 and 5.1 liters of oxygen successively in the last 3 minutes of this run and finishing with a blood lactic acid of only 47.5 mgm per cent. His highest R.Q. in this run was 0.99. In another experiment he reached an oxygen intake of 5.35 liters per minute in a run at 21.6 k.p.h. with no grade. This is approximately the same pace that he runs in his 2-mile race. If related to basal metabolism, this means that he elevated his metabolic rate to 21.4 times its basal level as compared to 14.5, the maximum of the best untrained man. This far exceeds previous records of a similar character, such as those of Henderson and Haggard[2] on Yale oarsmen, Christensen[3] on Danish cyclists and Hill[4] on Cornell runners. The high rate of oxygen intake which can be attained by these men is due largely to extremely high cardiac output, since their blood is normal in oxygen-carrying capacity.

The heart rates were recorded continuously throughout work and recovery by a cardiotachometer. The 5 runners performed the walk with an average pulse rate of 111 per minute, while the other men averaged 134. The average recovery is much quicker in the runners, dropping 34 beats to 77 in the first 30 seconds after stopping work, while at the same time in recovery the other group dropped 19 beats to 115. The next grade of work was hard enough to cause the untrained men to reach their maximum heart rates; they averaged 190, while the 4 runners who went through this run reached an average of 171. The hard work (not attempted by the untrained men) brought the blood lactic acid of the runners up to an average of 73 mgm per cent. and the average heart rate to 189, approximately the maximum of untrained man. The average heart rate for each group after the hardest work attempted is given in Fig. 2. Recovery took place at

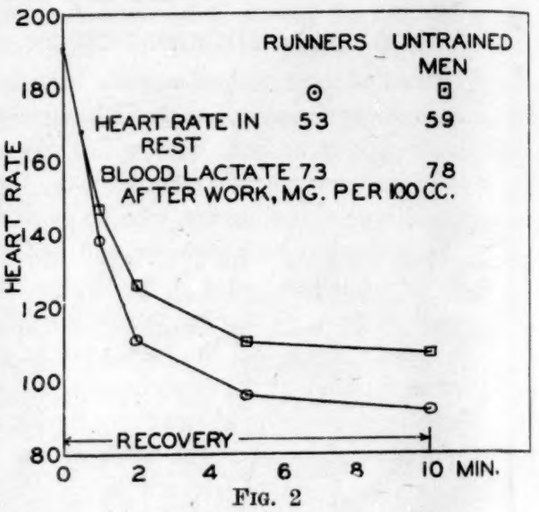

FIG. 2

the same rate in the first half-minute, after which the runners' pulse fell more rapidly.

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THE DIFFERENTIATION OF PANCREATIC TRYPSINS ON THE BASIS OF THEIR SPECIFICITIES

PANCREATIC juice contains at least three enzymes (trypsin, chymotrypsin, heterotrypsin[1]) which are capable of degrading genuine proteins. Synthetic substrates have been obtained recently for each of these enzymes. Thus, chymotrypsin has been found to digest simple derivatives of tyrosine and phenylalanine such as carbobenzoxy-*l*-tyrosylglycine amide and carbobenzoxyglycyl-*l*-phenylalanylglycine amide.[1] The existence of heterotrypsin was discovered because of its ability to split benzoylglycyl-*l*-lysine amide. It has now been found that crystalline trypsin readily hydrolyzes α-benzoyl-*l*-arginine amide.

The accessibility of synthetic substrates, the structure of which may be modified almost at will, makes it possible to perform comparative studies of the specificities of the various trypsins. The following table indicates the wide differences in chemical speci-

[2] Y. Henderson and H. W. Haggard, *Am. Jour. Physiol.*, 72: 264, 1925.

[3] E. H. Christensen, *Arbeitsphysiol.*, 5: 463, 1931.

[4] A. V. Hill, "Muscular Movement in Man," McGraw-Hill, 1927.

[1] M. Bergmann and J. S. Fruton, *Jour. Biol. Chem.*, April, 1937.

TABLE I

HYDROLYSIS OF SYNTHETIC SUBSTRATES BY PANCREATIC TRYPSINS

Substrate	Crystalline trypsin	Crystalline chymotrypsin	Hetero-trypsin
Benzoylarginine amide ...	+	–	
Carbobenzoxytyrosylglycine amide	–	+	
Benzoylglycyllysine amide.	–	–	+

ficity among crystalline trypsin (Northrop), crystalline chymotrypsin (Northrop) and heterotrypsin.

It may be mentioned that the substrates of trypsin and heterotrypsin both contain basic amino acid groups; nevertheless, this basicity is in itself not decisive for the specificity, since trypsin does not split the substrate of heterotrypsin. It has been reported[2] that chymotrypsin attacks the highly basic protamines which are extremely rich in arginine. This is of interest, since the artificial substrates of chymotrypsin do not contain a basic group and since chymotrypsin is unable to split either of the synthetic basic substrates of heterotrypsin and trypsin.

With the aid of the synthetic substrates exact estimations of each of the trypsins in the presence of each other become possible and their respective activities in various biological systems may be determined. Such an investigation of commercial pancreatin showed that this enzyme preparation splits benzoylglycyllysine amide much more rapidly than benzoylarginine amide. Therefore, pancreatin must contain a large amount of heterotrypsin and the activity of pancreatin toward genuine proteins must, to a large degree, be due to heterotrypsin.

The physiological rôle of the pancreatic trypsins is generally considered to be one of preparing the food proteins for a complete breakdown. If this be the only physiological function of the trypsins, it is difficult to understand why they exhibit such pronounced and narrowly limited specificities.

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[2] E. Waldschmidt-Leitz and S. Akabori, *Z. physiol. Chem.*, 228: 224, 1934.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

IGNEOUS ROCK TEXTURE DEMONSTRATION FOR STUDENTS OF ELEMENTARY GEOLOGY

THE study of igneous rocks by students of elementary geology is greatly facilitated by laboratory demonstration of the various types of texture, namely granitic, felsitic, porphyritic and glassy.

To demonstrate those textures in which either macroscopic or microscopic crystals are present to give a grained appearance to the rock, it is first necessary to prepare a supersaturate solution of sodium thiosulfate ($Na_2S_2O_3 \cdot 5\ H_2O$) by heating 100 cc tap water to boiling, then dissolving 200 grams sodium thiosulfate in the boiling water. The test-tube and its contents are cooled to or below room temperature by placing the test-tube and contents in cold running water. The cooled sodium thiosulfate solution is supersaturated.

For the formation of a granitic texture, place approximately 20 cc supersaturated sodium thiosulfate solution in a test-tube and inoculate the solution with a small particle of foreign material to start the crystallization. Crystals begun by the introduction of foreign material form aggregates which in arrangement of the individual crystals have the same arrangement as the crystals observed in igneous rocks of a granitoid texture.

The fine, almost microscopic, size crystals characteristic of felsitic textures may be obtained by violently shaking a test-tube containing 20 cc supersaturated sodium thiosulfate solution. The agitation of the supersaturated solution causes the formation of large numbers of minute crystals which accumulate on the bottom of the container. The crystalline character is distinctly seen when the accumulation at the bottom of the container is examined with a hand lens.

Two distinct sizes of crystals may be obtained in a single test-tube by first inoculating 20 cc supersaturated solution of sodium thiosulfate with a particle of foreign material and allowing the crystal aggregate to become well developed. The container with the developing crystal aggregate should be violently agitated by shaking so as to cause the formation of minute crystals, which in falling to the bottom of the container mix with the larger crystals of the aggregate to form porphyritic texture.

Glassy texture, such as is represented in obsidian, can be demonstrated by placing a 250 cc beaker half filled with granulated sugar over a Bunsen burner and heating slowly. The heating must be slow enough that the sugar melts without burning. If the melted sugar is poured into a beaker of cold water or on a cold surface, the resulting rapid cooling will form glassy textured masses.

The procedures mentioned above are not in themselves new but merely represent an application of elementary chemical and physical principles in experiments that can be conducted as classroom demonstrations to aid the student of elementary geology in

understanding the different textures found in igneous rocks and the relation of each to relative rates of cooling necessary to produce them.

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USE OF NILE BLUE SULFATE IN MARKING STARFISH[1]

THIS method was developed by the writer in the summer of 1935 and has been used very successfully for the past two years in his studies of the migration of starfish population of Long Island Sound and in connection with other problems where the marking of the individual starfish was desired.

The method consists in immersing living starfish in a solution of Nile Blue Sulfate for a short period of time. The solution is prepared in the following way: One gram of Nile Blue Sulfate is dissolved in a small volume of distilled water and then diluted with sea water to make up one liter of solution. If a large number of animals is to be stained at the same time, it is more convenient to prepare about 10 liters of solution at once. Dr. G. Gruebler and Co.'s Nile Blue Sulfate gives the best results.

When the solution is ready the starfish are placed in it. To avoid the suffocation of animals the solution should be aerated. The normal starfish (*A. forbesi* and *A. vulgaris*) are usually of orange-red color. After being placed in a freshly made solution of the dye, the animals acquire a very deep blue color in from 3 to 5 minutes, but as the solution weakens, longer immersion is necessary. According to my experience it is possible to stain several hundreds of medium-sized starfish, using one gram of the dye. The method can be used equally well for the marking of small or large starfish. Small, rapidly growing starfish, however, retain the color for considerably shorter periods than large ones. In the studies of the migration of starfish population of Long Island Sound, many large starfish were recovered 10 months after they had been stained and released in the Sound. At the end of the 10-month period the blue color was considerably faded but still quite deep.

In experimental work occasion often arises when each starfish has to be marked so as to be distinguishable from all other animals used in the same experiment. In such cases, the Nile Blue Sulfate method is indispensable because of the simplicity of its use. Any ray or any portion of the starfish's ray can be quickly stained by immersing it in the solution of Nile Blue Sulfate for several minutes. The stain is localized in the immersed part of the starfish and does not spread over the entire animal.

[1] Published with the permission of the U. S. Commissioner of Fisheries.

The simplicity and efficiency of this method is readily apparent if it is remembered that the self-mutilating tendencies of starfish prohibit the use of any other method of marking such as attachment of tags or cutting off portions of the rays.

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U. S. BUREAU OF FISHERIES

A PORTABLE HOOD FOR SMOKING KYMOGRAPH DRUMS

MODIFICATIONS of the apparatus described by Williams[1] in SCIENCE produced a portable hood which is fully effective at a cost of $7.00.

An end board of the proper dimensions was removed from a tight packing box, the dimensions of which were 27″ × 17″ × 16″. Over this aperture was placed an older model dismantled Hoover sweeper. A sheet of tinplate, 7½″ × 16″, was fastened across the top portion of the open side, and the box was entirely lined with tin. The original plan called for a hose through which the smoke could be expelled. Great was our satisfaction to find that the sweeper's sack would retain all carbon, even if benzene were used!

Increases of one or two inches in the above specifications should not adversely alter the effectiveness of the apparatus. Experience shows that decreases are not to be recommended.

The Hoover sweeper is peculiarly adapted to this work because of its wider suction opening. Sweeper companies resell used machines of the vintage in question, after reconditioning the motor, for $6.00.

EDGAR P. JONES

UNIVERSITY OF AKRON

[1] G. W. Williams, SCIENCE, 81: 2106, 465–466, 1935.

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